National Aeronautics and Space Administration

NASAfacts

Hubble Space Telescope Servicing Mission 4 Gyroscopes

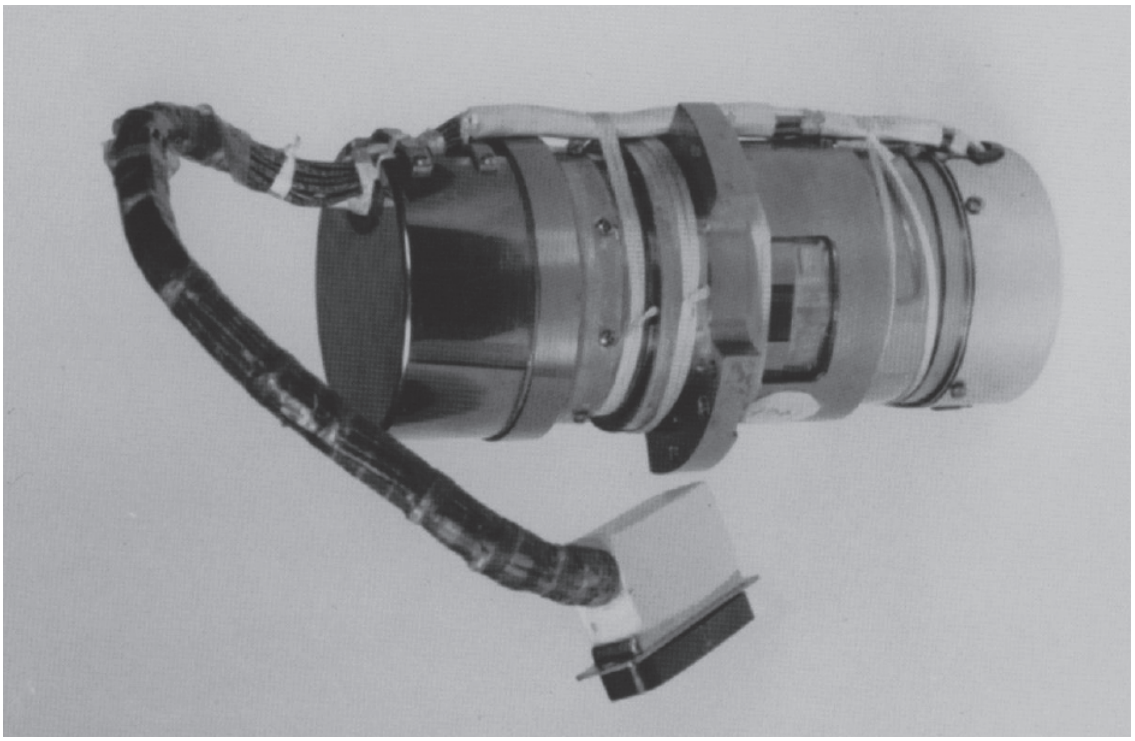
During Servicing Mission 4 (SM4), astronauts will replace all six of Hubble's gyroscopes, which are needed to point the spacecraft. Gyroscopes, or gyros, measure rates of motion when Hubble is changing its pointing from one target (a star or planet, for example) to another, and they help control the telescope's pointing while scientists are observing targets.

Previously, Hubble needed three of the six gyros to conduct science, and the other three function as spares. However, after substantial changes to Hubble's pointing control algorithms, only two gyros are now needed.

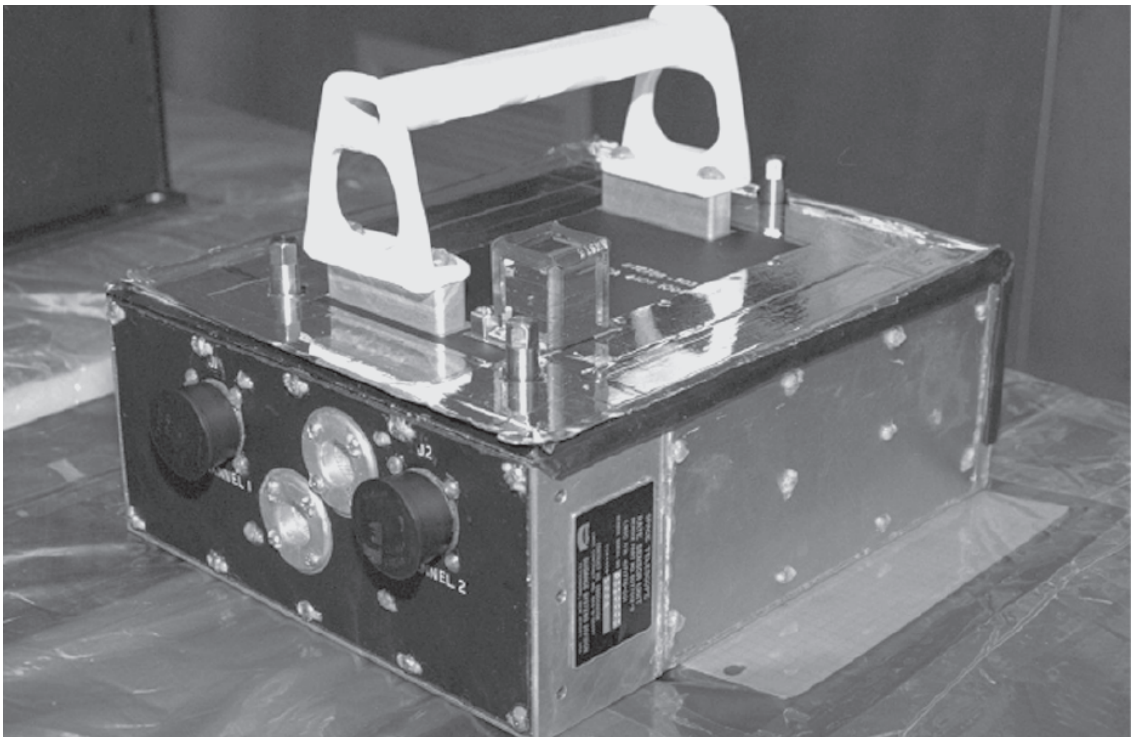
How Gyros Work

Gyros are used to maintain orientation and provide stability in boats, aircraft and spacecraft. They work by a scientific principle called the gyroscopic effect. You can demonstrate this effect by holding a bicycle wheel by its axle and asking someone to spin the wheel. If you try to move the axle of the spinning wheel, you will feel a force opposing your attempt to move it. This force is similar to the one produced in the gyros when Hubble moves.

The gyroscopic function is achieved by a wheel inside each gyro that spins at a constant rate of 19,200 rpm on gas bearings. This wheel is mounted in a sealed cylinder, which floats in a thick fluid. Electricity is carried to the motor by thin wires (approximately the size of a human hair) that are immersed in the fluid. Electronics within the gyro detect very small movements of the axis of the wheel and communicate this information to Hubble's central computer.



Rate Sensor Assembly



Rate Sensor Unit

Each gyro is packaged in a Rate Sensor assembly. The assemblies are packed in pairs inside boxes called Rate Sensor Units (RSUs). It is the RSU that astronauts change when they replace gyros, so gyros are always replaced two at a time.

The Best Gyros in the World
Several different types of gyros are available, such as the mechanical gyro that uses ball bearings instead of gas. Other gyros use light or the frequency of a resonating hemisphere to detect movement. While all these methods can provide information on the movement of the telescope, only gas-bearing gyros offer extremely low noise with very high stability and resolution. Gas-bearing gyros are the most accurate in the world, and Hubble uses the best gas-bearing gyros available.

Hubble's gyros are extraordinarily stable and can detect extremely small movements of the telescope. When used with other fine-pointing devices, they keep the telescope pointing very precisely for long periods of time, enabling Hubble to produce spectacular images of galaxies, planets and stars and to probe to the farthest reaches of the universe.

The Status of Hubble's Gyros
Gyros have limited lifetimes and need to be replaced periodically. Currently, three of the six gyros are working.

In 2005 Hubble began operating in two-gyro mode. With two useable spare gyros, Hubble's operating life can be extended and thus Hubble's science observations can continue uninterrupted until SM4.

History of Gyro Replacement
Four new gyros were installed on Hubble in 1993 and all six gyros were replaced in 1999. During SM4 in 2008, astronauts will replace all six gyros, which are nearing the end of their projected useful life.

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Or visit the Hubble website at:
www.nasa.gov/hubble

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